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ABSTRACT

Students in grades 1-6 who were part of the norming sample for the Kaufman Test of Educational Achievement took both a word identification task, Reading and Decoding, and a spelling test. Each word in both tests was coded for linguistic components: number of phonemes, consonant blends, vowel digraphs, consonant digraphs, r-controlled vowels, silent markers, and regular or irregular pronunciation/spelling of the word. For each student a regression analysis was performed to predict whether the student could successfully pronounce (spell) the word using the linguistic components as predictors. Regression weights were then used in various multivariate analyses along with overall word identification and spelling performance to investigate relationships among the variables. Correlations among the two sets of variables (word identification and spelling linguistic components and achievement) indicated generally high correlations at all grades among linguistic components and achievement, and between word identification and spelling achievement. Structural equation models were developed at each grade. Specific patterns varied at each grade level that appeared to be consistent with instructional emphases at each grade level in both reading and spelling. For example, phonemic length was important at grades 1-2 but not beyond for both reading and spelling, while components such as vowel digraphs and silent markers varied with grade in their importance for reading and spelling. Findings suggest that word regularity is more important to spelling than reading beyond grade 2, as students encounter increasingly difficult spelling words. Regularity in word identification does not appear to play a role in upper grade activities. (Contains 10 references, 1 table and 8 figures of data.) (Author)

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The Relationships Among Orthographic Components of Word Identification and Spelling for Grades 1-6

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Abstract

Students in grades 1-6 who were part of the norming sample for the Kaufman Test of Educational Achievement took both a word identification task, Reading and Decoding, and a spelling test. Each word in both tests was coded for linguistic components: number of phonemes, consonant blends, vowel digraphs, consonant digraphs, r-controlled vowels, silent markers, and regular or irregular pronunciation/spelling of the word. For each student a regression analysis was performed to predict whether the student could successfully pronounce (spell) the word using the linguistic components as predictors. The regression weights were then used in various multivariate analyses along with overall word identification and spelling performance to investigate relationships among the variables.

Correlations among the two sets of variables, word identification and spelling linguistic components and achievement indicated generally high correlations at all grades among linguistic components and achievement, and between word identification and spelling achievement. Structural equation models were developed at each grade, treating linguistic components as exogenous variables and achievements as endogenous. Specific patterns varied at each grade level that appeared to be consistent with instructional emphases at each grade level in both reading and spelling. For example, phonemic length was important at grades 1-2 but not beyond 2 for both reading and spelling, while components such as vowel digraphs and silent

markers varied with grade in their importance for reading and spelling. Word regularity is more important to spelling than reading beyond grade 2, as students encounter increasing difficult spelling words. Regularity in word identification does not appear to play a role in upper grade activities.

The Relationships among Orthographic Components of Word Identification and Spelling for Grades 1-6

Word identification and the factors that contribute to it have received a great deal of attention in recent years, particularly from a cognitive perspective (e.g., Adams, 1990). Willson and Rupley (1993) demonstrated the relationship between orthographic components of words in a word identification task to identification performance for children in each of the elementary years. Willson (1994) developed a methodological procedure based on regression for individual student predictions. Several studies have demonstrated in that word identification is highly related
to reading comprehension for children in the elementary grades. The high relationship of the orthographic features to reading, especially in the earlier grades, led the authors to investigate if similar processes were operating in spelling, a task with some similar, although also different, orthographic demands. In place of remembering or constructing letter combinations to make sense and remember words, spelling requires production of letter combinations or their retrieval from memory to determine the correct letter order to represent the spelling of words.

Spelling has been studied primarily from a developmental perspective. Gerber and Hall (1987) developed a comprehensive model of spelling development as a stage model. The authors

considered a systematic investigation of possible orthographic productions or deficits in production as a means to examine some of the cognitive tasks involved in spelling. Treiman (1933) focused on first graders' efforts to learn to spell. Her focal point was the phoneme, noting that for both instruction and understanding of students' production at this grade the phoneme produces understandable theory and explanation not possible at the level of the word. The authors' theoretical model assumed that linguistic features of words in the word identification task are predictive of word identification performance overall, that linguistic features of spelling words predict spelling achievement, and that the two sets do not predict each other except for a directional relationship between word identification and spelling.

Spelling itself can be parsed into the production and identification tasks that may be quite discrete. In the tasks of this study, single word spelling identification was employed, so that the results may not generalize to spelling production. Since single word identification tasks are likely to use the same cognitive processes as spelling identification, investigating student responses in the same mode may provide better understanding of the processes.

Word regularity was a feature of earlier spelling and word identification tasks, but has been attacked as too simplistic by connectionists (e.g., Seidenberg & McClelland, 1989), who argue that students recognize words from connected sets that have similar properties, some of which may be regular and some

irregular. Treiman (1993) suggested that there was virtually no real research on spelling since the connectionist research focused on reading. We did not abandon the regularity construct in this study since regularity still may be a general component of identification, while there appears to be no evidence at all for its efficacy in spelling.

Ehri (1986), Gough, Juel, and Griffith (1992) have documented the relationship between reading and spelling achievement in first grade. Fairly high correlations are reported in most achievement batteries for reading and spelling performance at all grade levels. Word identification is less commonly included in such batteries beyond the early grades, but its consistent relationship to reading comprehension predicts that high correlations should also be the rule between spelling and word identification.

The use of linguistic analysis of words has received support from both cognitive theorists such as Chomsky and Hall (1968) and from more recent work by Treiman (1993) and Willson and Rupley (1995). The latter researchers demonstrated consistent relationships between orthographic and linguistic features of words in identification and reading comprehension across the elementary grades. This study extends that research to linkages with spelling identification. A working theoretical model was that the importance of a particular linguistic feature would vary from child to child, and that it is crucial to estimate the importance to the child. Once the salience of a feature for a child was estimated, that salience can be compared between word

identification and spelling identification tasks. If the presence of a silent marker is helpful to one child and troublesome for another in word identification, that will result in a different regression weight in predicting the children's performance on words with and without silent markers. Similarly, in spelling identification the presence of a silent marker may help or hinder those children. Weights can be estimated for a child through individual regressions of item-level performance on item characteristics for all orthographic components of the words. Those weights can then be variables in hierarchical analyses of between-child models. Such analyses can best be represented through structural equation modeling (SEM); a similar approach in methodological literature has been termed hierarchical linear modeling (HLM).

A common initial SEM model was used for all grades: each linguistic component's regression weight was assumed to be an exogenous predictor of single word identification and single word spelling. Word identification was assumed to predict spelling, and it was assumed that there would not generally be paths between the word identification linguistic component regression weights and either spelling achievement or spelling linguistic component regression weights. Also, it was assumed that such single word identification achievement would affect only spelling achievement and not the spelling linguistic component regression weights. Thus, our theoretical model, shown visually in Figure 1, predicted that linguistic components' importance for word identification would only predict word identification, linguistic

components for spelling would predict only spelling, and word identification would predict spelling.

METHOD

Sample

Subjects were the normative sample of the Kaufman Test of Educational Achievement (KTEA) (Kaufman & Kaufman, 1985), a national sample selected to mirror the 1980 census of the U.S. population. At each grade level from 1-6, 100 students were tested.

Instrumentation

The Reading Decoding and Spelling subtests of the KTEA were selected for evaluation. Each reports reliabilities in the .8-.9 range by grade. The Word Identification test consists of 60 words selected to reflect regular and irregular words of varying difficulty from standard word lists encountered by children in grades 1-12. At a given grade, students attempt only a portion of the words, typically about 40 words. Older students begin with more difficult words. Spelling identification consists of 49 words selected from various grade based on published spelling tests using both statistical and orthographic features criteria. Students at all grades begin with the first word and attempt all words. All test scores were based on the number of correct responses.

Linguistic Analysis

Each word in both decoding and spelling tests was analyzed

by the authors for number of phonemes, presence of a vowel digraph, consonant blend, consonant digraph, r-controlled vowel, silent marker, and whether the word was regular or irregular in pronunciation. Reliability of the classification approach 1.0, with disagreements between experienced linguists reviewed and resolved.

Procedure. A separate regression analysis was conducted for each child to predict word identification word-level score (0 or 1) from the linguistic features predictors, with another analysis for the spelling list. Formally, this analysis is identical to discriminant analysis for predicting two groups' membership (Right vs. Wrongs) from a predictor set of continuous variables. While for many words most of the predictors took a value of 0 (absent) or 1 (a single count was present in the word), in some cases 2 instances occurred in the word, so that we properly considered the predictors to be interval in character. Number of phonemes varied from 3 to 12. The potential restriction of range in the number of linguistic components present in a given elementary-level word is expected to restrict the correlation and limit covariation, so that analyses were expected to be conservative in finding significant relationships. Regression coefficients for each child from word identification formed one variable set and coefficients for each child from the spelling words the other. The two sets were related using canonical correlation. This procedure was employed to investigate patterns of relationship between the two orthographic variate sets. The canonical analysis was viewed as exploratory, intended to examine

possible underlying structures among the variables representing the importance of linguistic components of word identification with those of spelling.

A second analysis was intended to be more theoretically driven and focused on the two predictor sets' relationship to word identification performance and spelling achievement. Structural equation modeling (SEM) was used to explore theoretically a model presented visually in Figure 1.

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insert Fig .1 about here

The structural model in Figure 1 mirrors the research reported in the introduction: word identification affects spelling performance. However, there is no indication in the literature that spelling performance affects word identification, but this alternative was available empirically for investigation in the SEM analysis through examination of modification indices for bi-directional paths; these were explored after the theoretical model was fit. The same model was the starting point for analysis at each grade level. Hypothesized paths were tested liberally at $p<.10$ for removal, while tests to add paths were tested conservatively at $p<.001$, since there are dozens of such tests in each model, given the number of variables and error terms specified. In addition, The Adjusted Goodness of Fit (AGFI) Index, chi square statistic for nonfit of the model, and normal fit index (NFI) were reviewed for each model, selected based on recent research on robustness and purpose for use

(Tanaka, 1993). Also, no error paths were fit since there is no theoretical support for them at this point. All exogenous variables were allowed to covary with each other without restriction. Covariances within either word identification or spelling are not reported, but covariances between the two sets were identified when they exceeded .40 in correlation, a working definition for significance beyond $p<.001$ (not an exact test). That is, these covariances were shown in the figures but all covariances were left free in the modeling procedure.

RESULTS

Grade 1

The first canonical function relating linguistic component regression weights for word identification to those for spelling was significant ($F(42,406)=2.59$, $p<.001$). Phonemes, consonant digraphs, r-controlled vowels and vowel digraphs were most strongly related on the word identification side, while phonemes and regularity of words were most strongly correlated on the spelling side. When the structural model was analyzed, however, phonemes, vowel digraphs, and silent markers predicted word identification, and word identification, phonemes, consonant digraphs, r-controlled vowels, and regularity predicted spelling. The R^2 for word identification was .904, and was .740 for spelling, indicating a high degree of predictiveness for both achievement variables. Word identification correlated .81 with spelling, while the direct effect of word identification on

spelling was .626. The difference indicated that indirect or unanalyzed effects through the linguistic components contributed another .18. The lack of statistical significance for any single unanalyzed effects suggests that this discrepancy was spread across a number of the linguistic predictors. The adjusted goodness-of-fit (AGFI) was .8137, Benther and Bonnet normed fit index (NFI) was .970, and the chi square for lack of model fit was 12.43 (df=12 p> .05), indicating excellent model fit with no likely additional paths to be added or deleted. The SEM is presented visually in Figure 2.

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insert Fig. 2 about here

Grade 2

The first and second canonical functions relating linguistic component regression weights for word identification to those for spelling were significant: $F(49,375)=3.18$, $p<.0001$, and $F(36,327)=1.78$, $p<.006$. For the first function phonemes, vowel digraphs, and word regularity were most strongly related on the word identification side, while phonemes, consonant blends and vowel digraphs were most strongly correlated on the spelling side. For the second canonical function all components were related on the word identification side, while consonant blends and vowel digraphs were most strongly related on the spelling side.

When the structural model was analyzed, phonemes, consonant digraphs, r-controlled vowels, silent markers, and word

regularity predicted word identification, and word identification and regularity predicted spelling. Number of phonemes for word identification was predictive of number of phonemes for spelling. In both variables the weights were all negative, indicating that children who were able to access longer words had increasing difficulty with them but performed overall at a higher level than children for whom phonemes were not important- they had difficulty with all words at this grade. The R^2 for word identification was .728, and for spelling was .683; indicating a high degree of predictiveness for both achievement variables, although less than at first grade. Word identification correlated .80 with spelling, and the direct effect of word identification on spelling was .795. The similarity indicated that virtually no indirect or unanalyzed effects through the linguistic components were present. The AGFI was .840, NFI was .962, and the chi square for lack of model fit was 10.01 (df=14, p> .05), indicating excellent model fit with no likely additional paths to be added or deleted. The SEM is presented visually in Figure 3.

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insert Fig. 3 about here

Grade 3

The first canonical function relating linguistic component regression weights for word identification to those for spelling was not significant ($F(36,332)=1.44$, $p>.05$. When the structural model was analyzed, however, consonant blends, consonant

digraphs, and vowel digraphs predicted word identification, and word identification, vowel digraphs, silent markers, and regularity predicted spelling. The R^2 for word identification was .677, and was .643 for spelling, indicating a degree of predictiveness for both achievement variables still quite large but substantially lower for word identification than in grade 1. Spelling overall prediction remained at about the same level as for earlier grades. Word identification correlated .73 with spelling, while the direct effect of word identification on spelling was .606. The difference indicated that indirect or unanalyzed effects through the linguistic components contributed about .12, or about one-fifth the contribution of word identification. The lack of statistical significance for any single unanalyzed effects suggests that this discrepancy was spread across a number of the linguistic predictors. The AGFI was .896, NFI was .979, and the chi square for lack of model fit was 7.07 ($df=7$, $p> .05$), indicating excellent model fit with no likely additional paths to be added or deleted. The SEM is presented visually in Figure 4.

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insert Fig. 4 about here

Grade 4

The first canonical function relating linguistic component regression weights for word identification to those for spelling was significant ($F(49,390)=2.12$, $P<.0001$, with $R^2=.39$. All

linguistic components were related on the word identification side, as well on the spelling side, leaving a fairly uninterpretable result.

When the structural model was analyzed, however, consonant blends, consonant digraphs, and word regularity predicted word identification, and word identification, consonant blends, consonant digraphs, vowel digraphs, silent markers, and regularity predicted spelling. The R^2 for word identification was .552, and was .685 for spelling, supporting the observed decline in prediction of word identification while retaining the same degree of predictiveness in spelling. Word correlated .75 with spelling, while the direct effect of the word identification on spelling was .525. The difference indicated that indirect or unanalyzed effects through the linguistic components contributed another .22. The lack of statistical significance for any single unanalyzed effects suggests that this discrepancy was spread across a number of the linguistic predictors. The AGFI was .754, NFI was .949, and the chi square for lack of model fit was 17.58 (df=10, p> .05), indicating still excellent model fit with no likely additional paths to be added or deleted. The SEM is presented visually in Figure 5.

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insert Fig. 5 about here

Grade 5

The first and second canonical functions relating linguistic component regression weights for word identification to those for spelling were significant ($F(49,395)=2.377$, $p<.0001$, and $F(36345)=1.76$, $p< .006$, respectively. Phonemes, consonant digraphs, and word regularity were correlated to the first function on the word identification side, while r-controlled vowels and word regularity were correlated on the spelling side for the first function. For the second canonical function, on the word identification side, phonemes, consonant digraphs, and word regularity were correlated, while spelling phonemes, consonant blends, consonant digraphs, and silent markers were correlated.

When the structural model was analyzed, phonemes, consonant blends, consonant digraphs, silent markers, and word regularity predicted word identification, and word identification, phonemes, consonant blends, vowel digraphs, and word regularity predicted spelling. The R^2 for word identification was .735, and was .798 for spelling, indicating a high degree of predictiveness for both achievement variables and increased productivity over grade 4. Word identification correlated .79 with spelling, while the direct effect of word identification on spelling was .612. The difference indicated that indirect or unanalyzed effects through the linguistic components contributed another .17. The lack of statistical significance for any single unanalyzed effects suggests that as at earlier grades, this discrepancy was spread across a number of the linguistic predictors. The AGFI was .692,

NFI was .941, and the chi square for lack of model fit was 26.54 (df=11, p<.05), indicating moderate model fit. The chi-square was significant for the first time in the analyses, indicting that other relationships not investigated could add significantly to the model. Inspection of the modification indices suggested that most of the lack model of fit could be accounted for by error covariances, although several paths between spelling components and word identification appeared significant. When they were explored the model seems to disintegrate, however, and model fit routinely decreased greatly. Thus, the model as presented in Figure 6 appeared to be the most stable and interpretable.

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insert Fig.6 about here

Grade 6

The first canonical function relating linguistic component regression weights for word identification to those for spelling was significant ($F(49,415)=2.22$, $p< .0001$. All linguistic components except word regularity were strongly related on the word identification side, while phonemes, consonant blends and digraphs, vowel digraphs, regularity of words were most strongly correlated on the spelling side. The R^2 for the function was .784, indicating a high degree of predictability between the linguistic components.

When the structural model was analyzed, phonemes, consonant

digraphs, r-controlled vowels, silent markers, and word regularity predicted word identification, and word identification, phonemes, consonant digraphs, r-controlled vowels, vowel digraphs, silent markers, and word regularity predicted spelling. The R^2 for word identification was .792, and was .777 for spelling, indicating a high degree of predictiveness for both achievement variables about the same as at grade 5. Word identification correlated .78 with spelling, while the direct effect of word identification on spelling was .490. The difference between correlation and direct effect indicated that indirect or unanalyzed effects through the linguistic components contributed another .29. The lack of statistical significance for any single unanalyzed effects except silent markers for word identification's effect on vowel digraphs and then spelling suggests that this discrepancy was spread across a number of the linguistic predictors in small increments. The AGFI was .512, NFI was .943, and the chi square for lack of model fit was 42.13 ($df=12$, $p<.01$), indicating inadequate model fit with additional paths to be added or deleted. Inspection of the modification indices suggested that model improvement would occur primarily through covariances among error terms. These were not theoretically relevant to this study and were not investigated further. The SEM is presented visually in Figure 7.

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insert Fig.7 about here

DISCUSSION

A first conclusion to be drawn is that word identification and spelling remain highly correlated through the elementary grades, a result widely reported in standardized achievement test manuals, and not new. That each can be highly predicted by the importance of linguistic features of the words in the tests comprising word identification and spelling is new, however. At each grade a significant and large squared multiple correlation was found when predicting word identification and spelling from individually modeled regression weights for seven linguistic features of words: number of phonemes, presence of consonant blends, consonant digraphs, r-controlled vowels, vowel digraphs, silent markers, and the words orthographic regularity or irregularity. At a given grade different combinations of the linguistic features were most important in the predictions, Some regularities were observed, however.

First, the effect of phonemic complexity of a word varied from grade 1 to grade 6 in a quite interpretable way. For grades 1 and 2 the number of phonemes was associated with increasing difficulty in identification for good decoders, while for poor decoders all words were equally hard. In grades 3 and 4 the number of phonemes had no effect on word identification, while at grades 5 and 6 the effect was now positive. That is, in the upper grades, good decoders had little more difficulty with longer words than shorter, while for poor decoders the number of phonemes was still important to their ability to identify a word. This effect is shown in Figure 8.

insert Fig. 8 about here

For spelling a similar phenomenon was observed, although it appears to be less salient than for word identification. Word regularity, although dismissed by the connectionists, appears to function in a regular way for word identification, primarily in grades 4-6. The positive path coefficient represents for most students an effect in which regularity is unimportant for good decoders but important for poor decoders, who have more difficulty with the irregular words. A similar phenomenon was noted for spelling. In grade 1 the effect was negative, comparable to the result for phonemes, and positive for grades 2 and 3. The effect was small and negative at grade 4 and virtually nonexistent at grades 5-6.

Consonant blends were important and a positive effect on word identification for grades 3-6. Since the coefficients for importance were mostly positive for all grades, this means that the presence of a consonant blend assists word identification at these grades. A very weak similar effect was seen for spelling at grades 4 and 5.

Consonant digraphs were moderately important for word identification at grades 2-6, but the effect was positive for grades 2-4 and negative at grades 5-6. This suggests that in the middle grades the presence of consonant digraphs aids identification but by grade 5, when most decoders have become automatic, those who have not achieved automaticity have greater

difficulty with digraphs. In the earlier grades they did not do any better or worse on words with consonant digraphs than on other words but by grade 5 do better on regular, simple words than words with consonant digraphs (and many other linguistic features that make a word more complex).

For spelling, consonant digraphs were always positively related to spelling, although the effect was small and nonsignificant at grades 2,3, and 5.

R-controlled vowels appeared to be important only at grade 2, a negative relationship with word identification. Students for whom r-controlled vowels were important tended to be poor decoders, while good decoders were indifferent to the presence or absence of an r-controlled vowel in their ability to decode. A smaller, similar effect was noted at grade 6. For spelling at grade 1 r-controlled vowels functioned in a way similar to that for word identification at grade 2: positive weights related negatively to spelling performance. At grade 6 a small positive effect was noted: poor spellers had difficulty with r-controlled vowels, while good spellers could use the presence of an r-controlled vowel to aid spelling.

Vowel digraphs were inconsistently but positively related to word identification. Good decoders have no difficulty with them, put poor decoders do worse on such words. The poorest decoders have the most difficulty with such words. For spelling a consistent positive effect for vowel digraphs on spelling was found from grade 3 onward, exhibiting a remarkably stable effect. It appears that students who have trouble with spelling do not

appear to improve in their spelling of words with vowel digraphs compared to other words.

Silent markers' effect on word identification is positive for grades 1 and 2, unimportant for grades 3 and 4, and negative for grades 5 and 6. The nature of the importance changes across these grades. For grades 1 and 2 the presence of a silent marker makes the word harder for students to decode overall, although students for whom the effect is small generally are better decoders, and students for whom the effect is large have difficulty with most words. At the upper grades the regression weights for silent markers are almost all positive. Good decoding students at these grades make use of silent markers to aid in decoding, while poor decoders cannot make use of their information. For spelling silent markers were not significant at grades 1 and 2, and negative for the upper grades, somewhat paralleling the effect for word identification, although, interestingly, alternating across grade with respect to significance.

The exploratory canonical analyses, while perhaps useful to document direct relationships among sets of linguistic components in decoding and spelling, proved less helpful in detecting structures that are interpretable. That appears in hindsight to be due to the primacy of relationship between overall word identification and spelling performance. The variance found to be in common in the canonical analyses can largely be explained by overall performance. The SEM analyses proved more useful in characterizing word identification and spelling performance. A

summary table is presented to aid in interpreting results. See Table 1.

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insert Table 1 about here

The effects reported here, based on a nationally selected sample, should give clues for investigation of a student's orthographic reading problems and linkage with similar spelling difficulties. With many of the linguistic features there appeared to be a change in direction of effect from the lower grades to the upper. Linguistic features that hindered performance in the lower grades gradually began to assist students in the upper grades if they had learned the rule structure associated with the effect.

That the importance of linguistic features in word identification and spelling vary within child and from child to child is an important finding, because it implies that different student processes are invoked in the two tasks. One cannot assume that because a student has mastered silent markers in word identification that the student can use them well in spelling. The decoupling of these components may complicate instruction but does suggest that both assessment and instruction should explicitly address each child's strengths and weaknesses in word identification and spelling separately.

Clearly the next step is to investigate systematic instruction that takes advantage of student profiles of orthographic components. Making use of individual strengths and

weaknesses has always been an ideal in educational theory. There appears that there is a quite useful role for returning to controlled text and specifically teaching the nature and contribution of each linguistic feature when needed by the student. That is, good decoders have different needs at each grade than students still having difficulty decoding, and controlled words selected individually to the students' profile might provide the instructional support needed to improve both decoding and spelling. This does not negate the role of spontaneous text but the clear conclusion is that individual student variability is so strongly predictive of performance in decoding that such text is inadequate for virtually all students except the most proficient in improving their reading and spelling performance.

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TABLE 1: Summary of importance of linguistic features on word recognition and spelling performance

WR= Word recognition performance
SP=Spelling performance

GRADE	# OF PHONEMES		CONSONANT BLENDS		CONSONANT DIGRAPHS		r-CONTROLLED VOWELS		SILENT MARKERS		VOWEL DIGRAPHS		WORD REGULARITY	
	WR	SP	WR	SP	WR	SP	WE	SP	WR	SP	WR	SP	WR	SP
6	++	+	+	0	-	+	+	+	-	-	0	+	+	0
5	++	+	+	0	-	0	0	0	-	0	0	+	+	0
4	0	0	+	+	+	+	0	0	0	-	+	+	+	-
3	0	0	++	0	+	0	0	0	0	-	+	+	0	+
2	-	0	0	0	+	0	+	0	+	0	0	0	-	+
1	--	-	0	0	0	+	0	-	+	0	+	0	0	-
D:	all negative		mixed		mixed		mixed		mixed		mixed		all negative	

D= distribution of regression weights, mixed meaning some weights were negative, some positive in value

Note: ++ means correlation over +.5
+ means correlation between .1 and .5
0 means correlation between -.1 and +.1
- means correlation between -.1 and -.5
-- means correlation below -.5

Figure captions

Figure 1; Theoretical model of the importance of linguistic features of words to word identification and spelling achievement

Figure 2: Grade 1 structural equation model relating linguistic features' importance to word identification and spelling achievement.

Figure 3: Grade 2 structural equation model relating linguistic features' importance to word identification and spelling achievement.

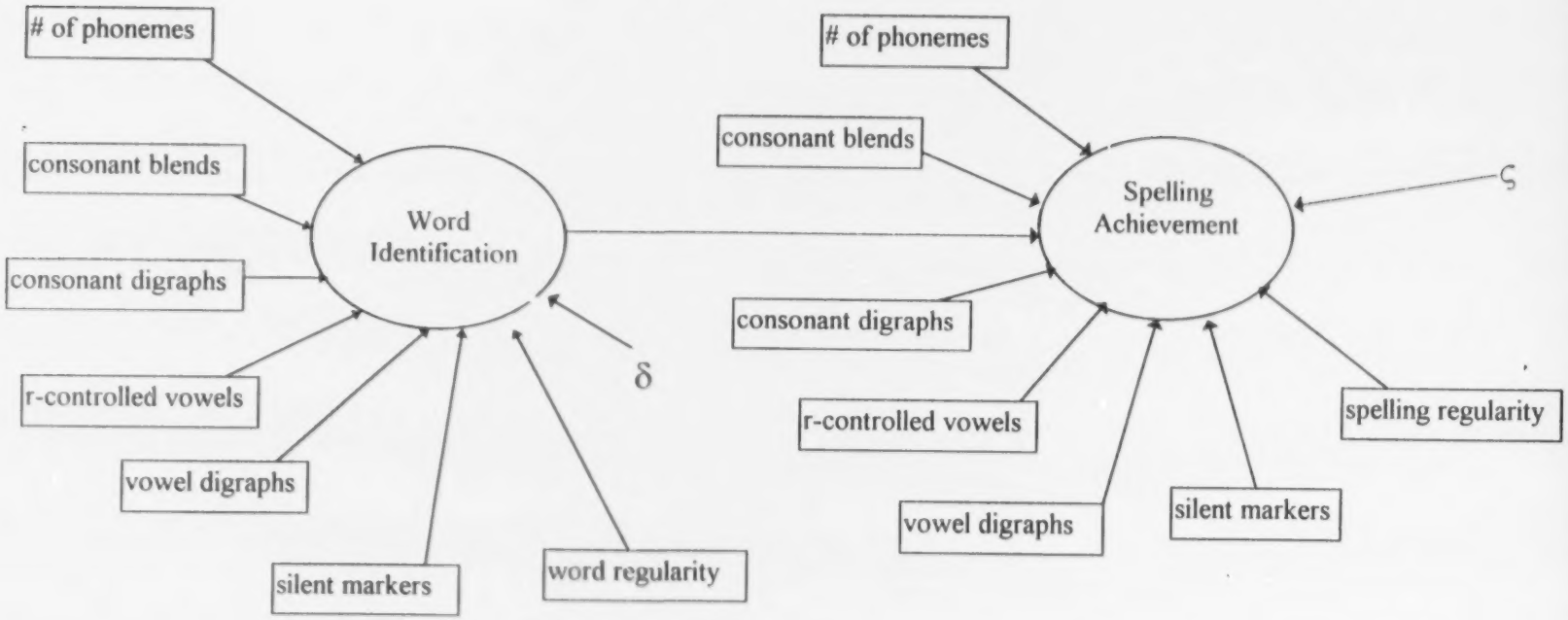
Figure 4: Grade 3 structural equation model relating linguistic features' importance to word identification and spelling achievement.

Figure 5: Grade 4 structural equation model relating linguistic features' importance to word identification and spelling achievement.

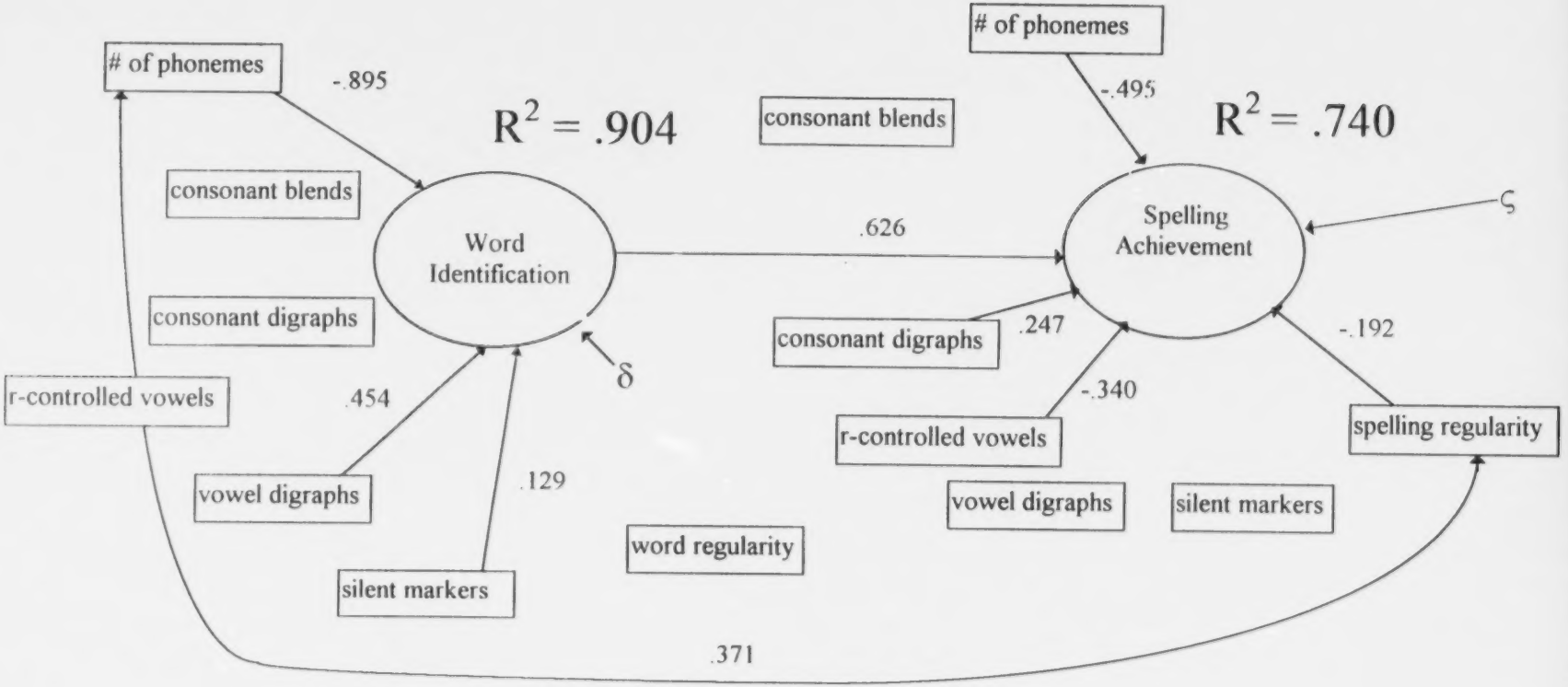
Figure 6: Grade 5 structural equation model relating linguistic features' importance to word identification and spelling achievement.

Figure 7: Grade 6 structural equation model relating linguistic features' importance to word identification and spelling achievement.

Figure 8: Examples of the relationship between importance of number of phonemes and word identification at grades 1 and 6.

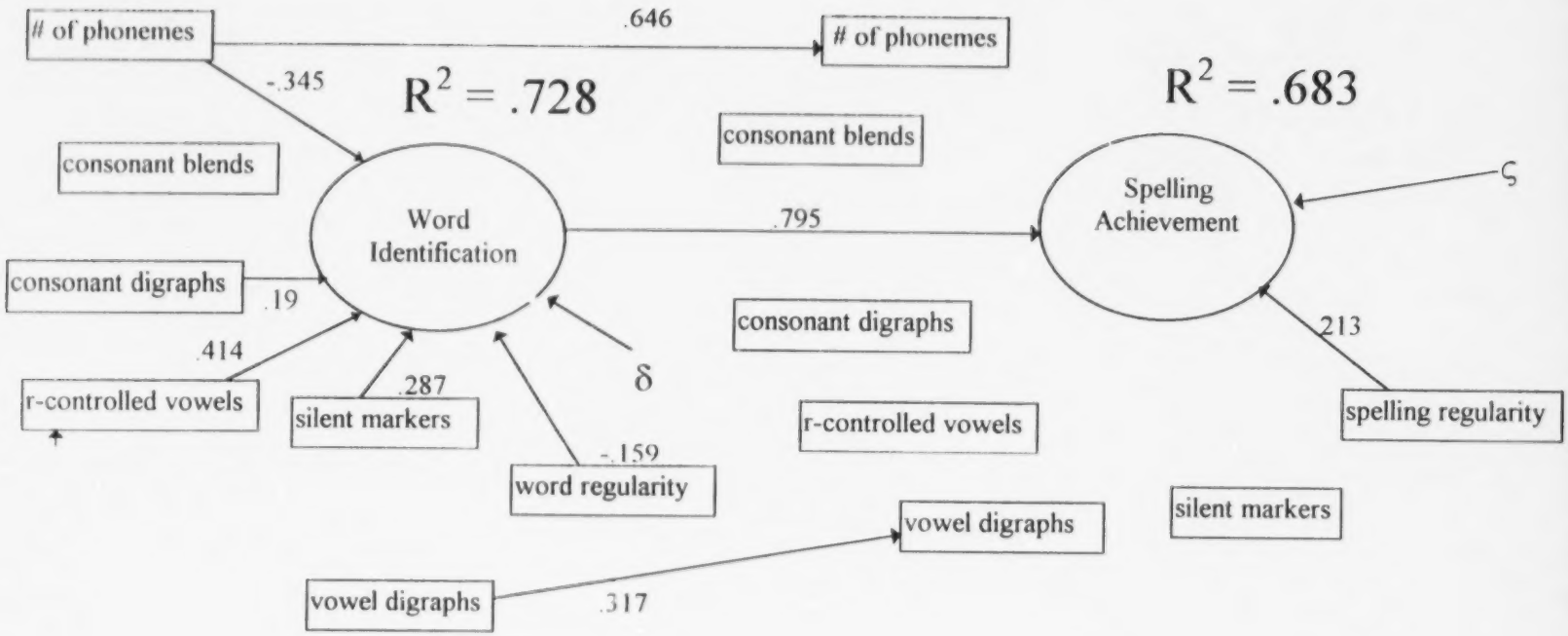


Theoretical Model of Importance of Linguistic Features of Words to Word Identification and Spelling Achievement

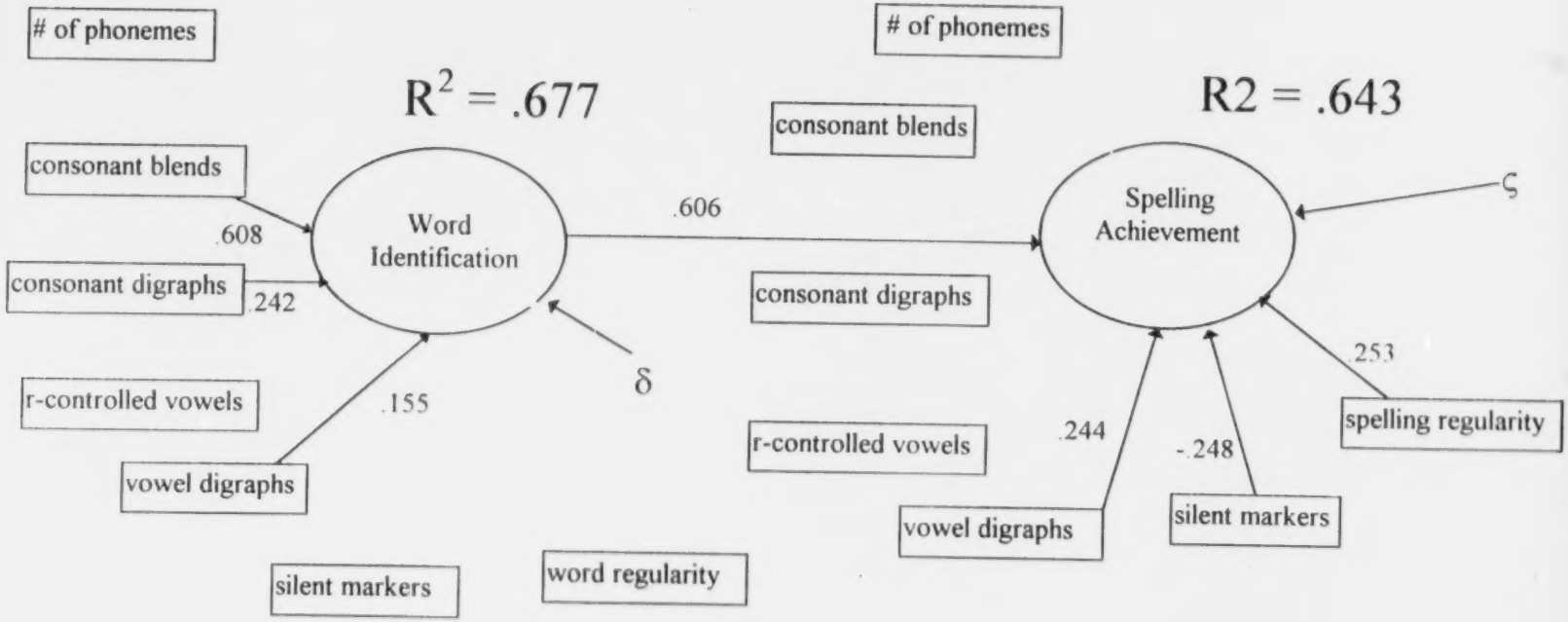


Note: 22 cases dropped because of zero decoding scores

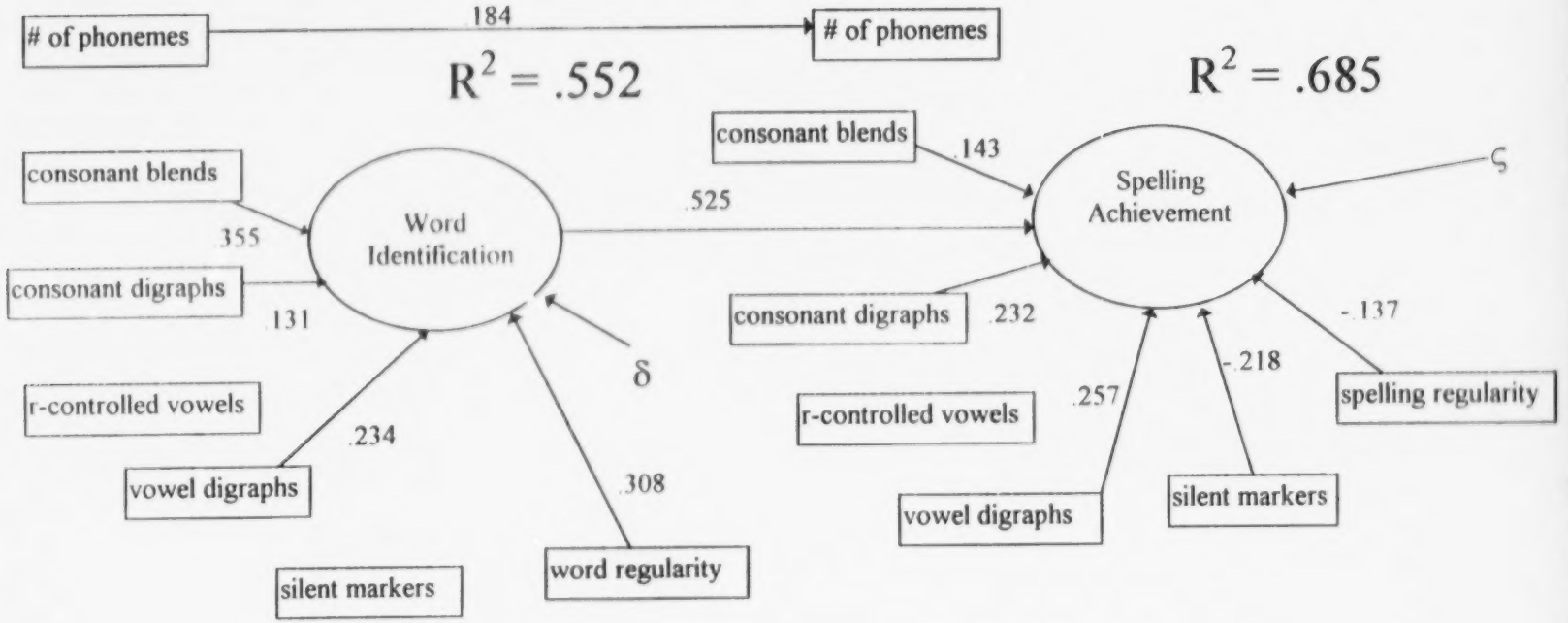
GRADE 1


# of phonemes
.646
# of phonemes
-.345
$R^2 = .728$
$R^2 = .683$
consonant blends
consonant blends
Word Identification
.795
Spelling Achievement
ς
consonant digraphs
.19
consonant digraphs
.414
.213
r-controlled vowels
.287
δ
r-controlled vowels
spelling regularity
silent markers
-.159
word regularity
vowel digraphs
silent markers
vowel digraphs
.317

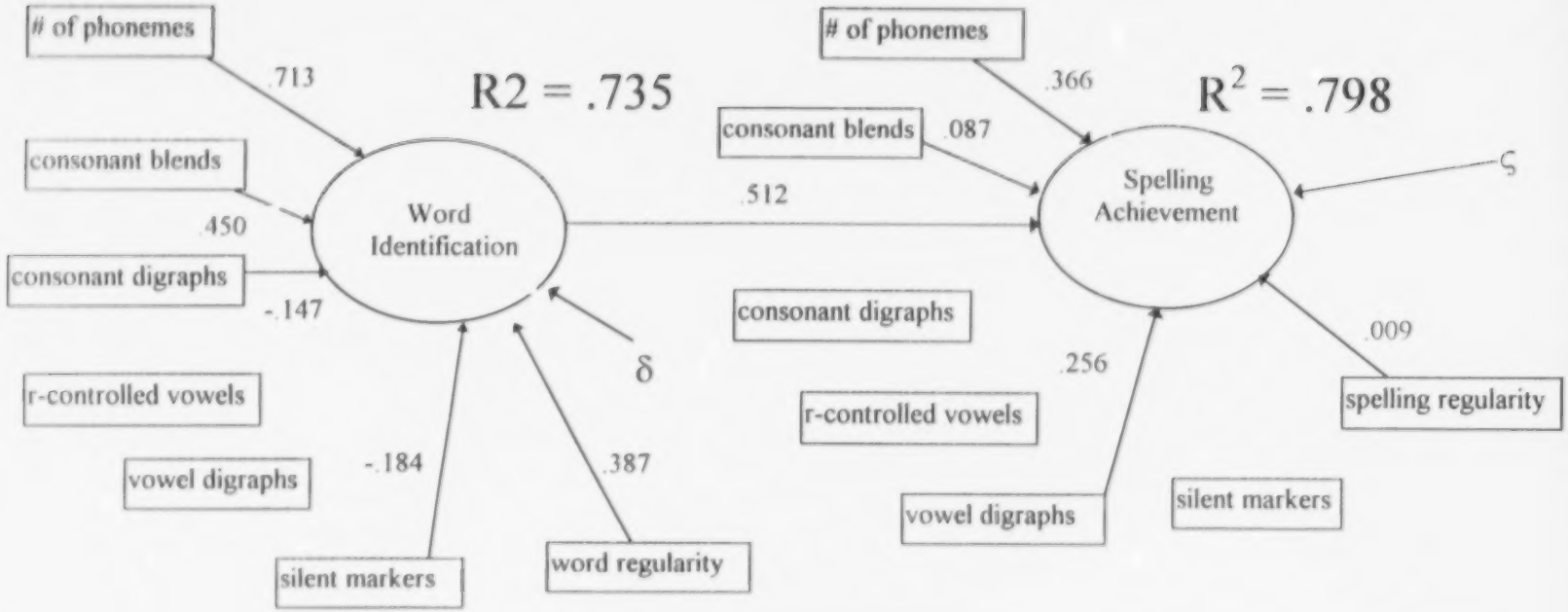
GRADE 2


# of phonemes
$R^2 = .677$
consonant blends
.608
consonant digraphs
.242
r-controlled vowels
vowel digraphs
.155
silent markers
word regularity
Word Identification
δ
.606
# of phonemes
R2 = .643
consonant blends
consonant digraphs
r-controlled vowels
.244
vowel digraphs
-.248
silent markers
.253
spelling regularity
Spelling Achievement
ς

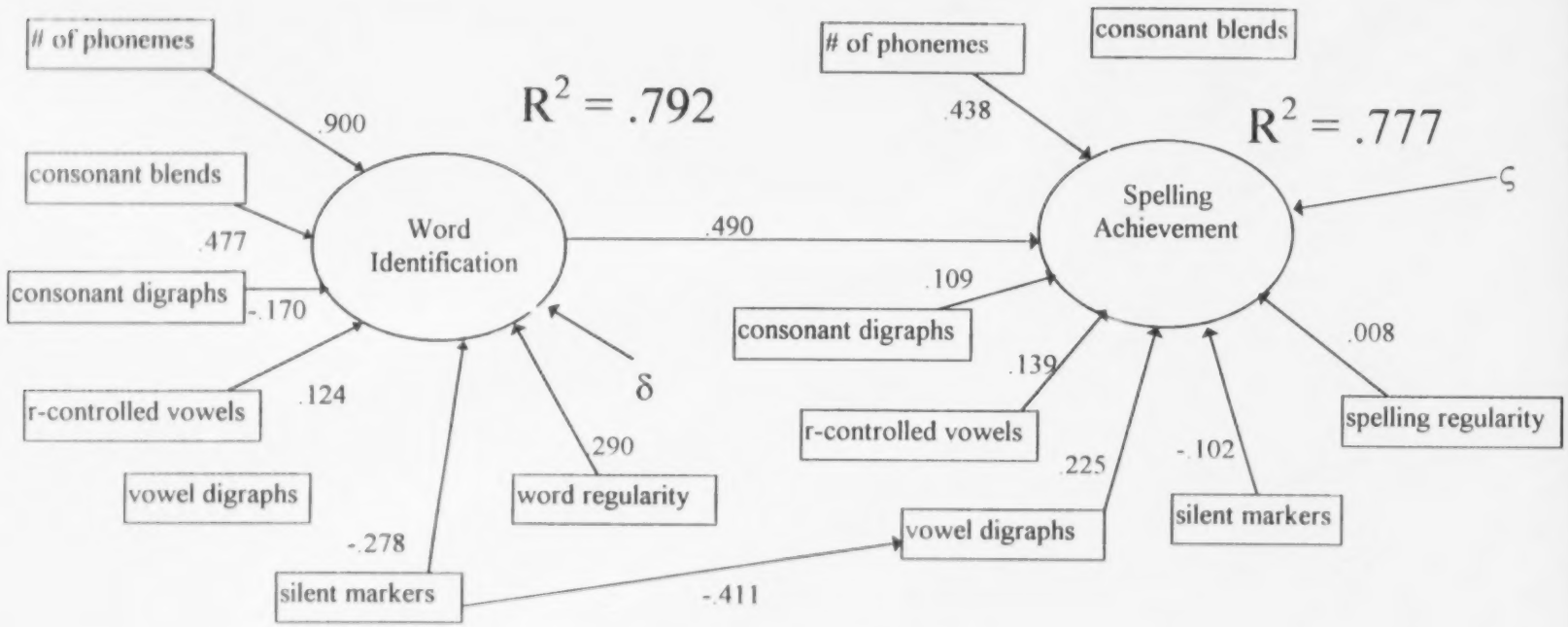
GRADE 3


# of phonemes
.184
# of phonemes
$R^2 = .552$
$R^2 = .685$
consonant blends
.355
consonant digraphs
.131
r-controlled vowels
.234
vowel digraphs
silent markers
Word Identification
δ
.308
word regularity
.525
consonant blends
.143
consonant digraphs
.232
r-controlled vowels
.257
vowel digraphs
Spelling Achievement
ς
-.137
-.218
silent markers
spelling regularity

GRADE 4


# of phonemes
.713
consonant blends
.450
consonant digraphs
-.147
r-controlled vowels
vowel digraphs
-.184
silent markers
R2 = .735
Word Identification
δ
.387
word regularity
.512
# of phonemes
.366
consonant blends
.087
consonant digraphs
.256
r-controlled vowels
vowel digraphs
R^2 = .798
Spelling Achievement
ς
.009
spelling regularity
silent markers

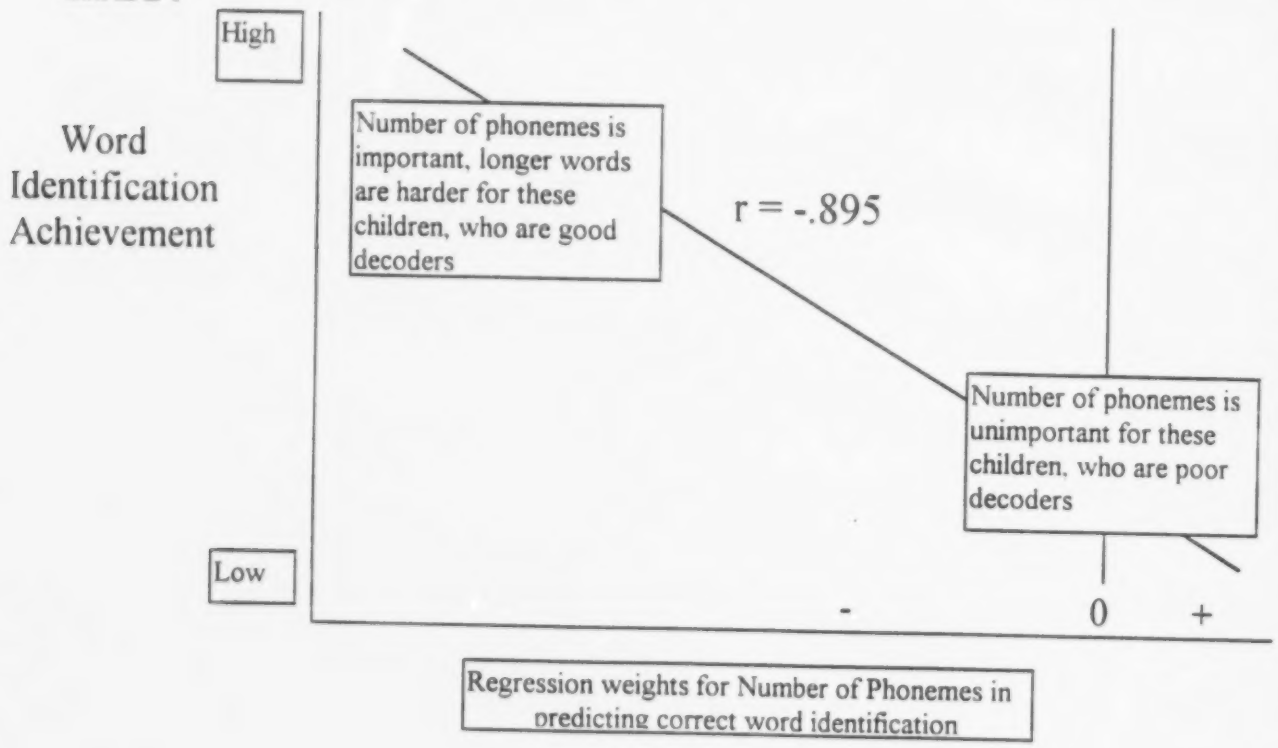
GRADE 5


# of phonemes
consonant blends
consonant digraphs
r-controlled vowels
vowel digraphs
silent markers
.900
.477
-.170
.124
-.278
.290
$R^2 = .792$
Word Identification
δ
word regularity
.490
# of phonemes
consonant blends
.438
$R^2 = .777$
Spelling Achievement
ς
.109
consonant digraphs
.139
r-controlled vowels
.225
vowel digraphs
-.411
-.102
silent markers
.008
spelling regularity

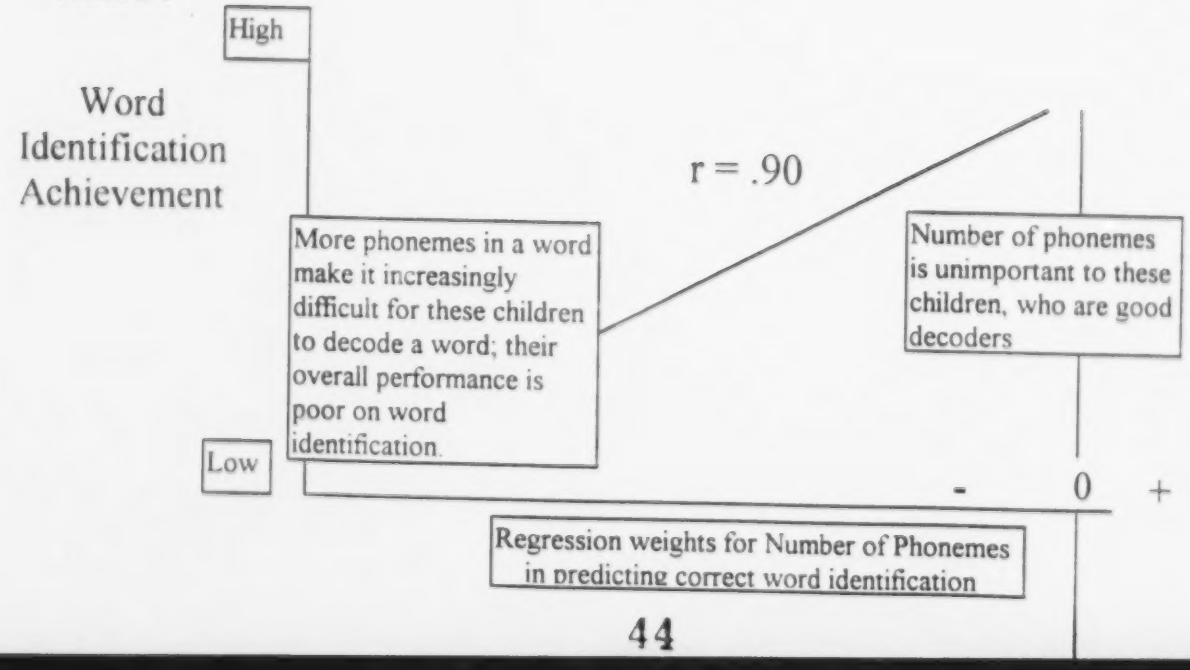
GRADE 6

EXAMPLES OF THE RELATIONSHIP BETWEEN IMPORTANCE OF NUMBER OF PHONEMES AND WORD IDENTIFICATION AT GRADES 1 AND 6

GRADE 1


High
Word Identification Achievement
Number of phonemes is important, longer words are harder for these children, who are good decoders
r = -.895
Number of phonemes is unimportant for these children, who are poor decoders
Low
-
0
+
Regression weights for Number of Phonemes in predicting correct word identification

GRADE 6


High
Word Identification Achievement
r = .90
More phonemes in a word make it increasingly difficult for these children to decode a word; their overall performance is poor on word identification.
Number of phonemes is unimportant to these children, who are good decoders
Low
-
0
+
Regression weights for Number of Phonemes in predicting correct word identification